

PLUTONIUM CONCENTRATIONS IN SOIL ON LANDS ADJACENT TO THE ROCKY
FLATS PLANT

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ENERGY SYSTEMS GROUP
ROCKY FLATS PLANT

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ADMIN RECORD

PLUTONIUM CONCENTRATIONS IN SOIL ON LANDS ADJACENT TO THE ROCKY FLATS PLANT

Introduction

Litigation proceedings were initiated against the Rocky Flats Plant claiming radionuclide depositions from the Plant on lands adjacent to the Plant caused the lands to be unfit for human habitation and use. To answer these claims, extensive soil and air sampling projects were conducted in 1976 and 1977. The procedures used in these projects and the results obtained were presented to the U.S. District Court, Denver, Colorado. Summary soil sample results are included in this document. Complete details concerning the litigation program are available. At the request of local landowners, a supplemental soil sample program was initiated in the summer of 1978 to characterize plutonium concentrations on other lands adjacent to the Rocky Flats Plant.

The number of sample sites per parcel of land was determined from a statistical evaluation of existing plutonium in soil data. A complete description of the procedures used is recorded in the transcript of "Hearings on Soil Sampling" held in U.S. District Court, Denver, Colorado, 1977 (Civil Action Numbers 75-M-1111, 75-M-1162, and 75-M-1296).

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The locations of seventy-one (71) soil sample sites were surveyed by a professional surveyor, marked on the ground and plotted on a topographic quadrangle map showing the land parcels. Soil samples were collected by Eberline Instrument Corporation by an approved collection technique. Five sub-samples were composited into one sample at each site. Eberline made preliminary sample preparation and delivered the samples to an independent escrow agent.

Sample batches were prepared by an independent escrow agent. Each batch contained blanks, synthetic standards, consensus standards, field samples and replicate field samples. The escrow agent provided a coded numbering system which made the various sample types indistinguishable from one another. The escrow agent submitted sample batches to Eberline, LFE and LASL laboratories for analysis.

The radiochemical procedure used for the determination of plutonium is a modification of the U.S. Nuclear Regulatory Commission Regulatory Guide 4.5 "Measurements Of Radionuclides In The Environment—Sampling and Analysis Of Plutonium In The Soil." The modified version of this procedure is part of the record in the hearings mentioned above.

The analytical data were reported to the escrow agent who decoded the sample numbers. After all analyses were completed, the analytical data were forwarded to the project management.

SAMPLE COLLECTION

Sample Site Locations

The 71 sample sites, shown on Figure 1, were located, staked, and marked on the ground by a professional licensed surveyor and crew from Drexel, Barrell and Company, Boulder, Colorado. It was necessary to deviate slightly from the indicated map sites because of the location of roads, fences and bodies of water. Each actual site, however, was accurately plotted on a map and the coordinates recorded by the surveyor. These alternate sites were selected by the project manager and the sampling crew chief.

Sample sites were marked on the ground by procedures to be described later. The sample sites were marked with a red capped stake showing map location and site number. These sites were considered as the centers of 10 meter diameter areas for sample collection. The site markers were all removed at the conclusion of sampling.

Color photographs were obtained at each sample site to verify the site number and to depict general topography, surface conditions and type and condition of vegetation.

SURVEYING PROCEDURES

Using the section lines of the respective sections, reference points were staked 50 feet due west of sample sites. Two reference points per sample site were used when possible livestock or farming activities might disturb the reference point. Numerical identification of reference points was used, inclusive for each section. Care was taken to insure that each test site remained undisturbed by vehicular or pedestrian traffic. Surveying and sampling were coordinated so that no more actual sites were located and surveyed than were to be sampled on that particular day.

GENERAL SAMPLING PROCEDURES

Soil samples were collected at each site by a technician under direct professional supervision. The technician had received prior training in the soil collection technique utilized. A description of this technique, which utilizes a 10 X 10 X 5 cm jig, is given in the Court record of Soil Hearings and also in the Rocky Flats Annual Environmental Monitoring Reports.

The plan of operation at each soil sample site was identical and details were recorded in a log book. Samples were collected 0.3 meters north of the site marker and at a distance of 5 meters from the site center at the four cardinal points. These 5 samples were composited in one new one gallon paint can.

The sample collection log book contains the following information:

- (a) Sample number
- (b) Sample location
- (c) Date of collection
- (d) Name of collector
- (e) Weather conditions
- (f) Soil type
- (g) Vegetation
- (h) Degree and direction of slope
- (i) Soil moisture
- (j) Any special conditions

SOIL COLLECTION PROCEDURE

Field Procedure

One composite soil sample was collected at each site. This composite consisted of five samples 5 centimeters deep. Each sub-sample was taken using a sample jig which outlines an area 10 by 10 centimeters square. The jig was driven into the ground to a depth of 5 centimeters and a scoop was used to remove the soil from inside the jig cavity.

The five surface samples were composited in a new one gallon metal paint can and the lid was sealed with melted sealing wax. The sample container was labeled with sample number, sample location, date and signature of collector.

Laboratory Procedure

Prior to radiochemical analysis, each soil sample was placed in a clean metal pan and oven dried at 110°C. After drying, the samples were weighed. The sample was then sieved through a 10 mesh screen. Oversize material was weighed and discarded. The fine material was weighed and returned to the original sample can. The can was rotated on a ball mill (without balls) at 120 rpm for 30 minutes. The sample was then coned and quartered and split into two equal fractions. One fraction was transferred to a new can and labelled with the sample number. This material is held as reserve sample. The other soil fraction was returned to the original sample can.

Ten 1-inch steel grinding balls were placed in each sample can and the can was rotated on a ball mill at 120 rpm for at least 4 hours. One hundred gram aliquots of the homogeneous fine powder were transferred to plastic bottles and labelled.

All sample aliquots were delivered to the independent escrow agent who prepared ten gram aliquots for radiochemical analysis. The escrow agent submitted batches of 23 "unknowns" to the laboratories. Each batch included field samples, replicate field samples, synthetic standards, consensus standards and blanks.

ANALYSIS OF SOIL FOR PLUTONIUM

All soil samples were analyzed for plutonium 239 plus 240 and plutonium 238 by a radiochemical procedure using alpha particle counting. The method of analysis was that specified in NRC Regulatory Guide 4.5 as modified. An isotopic tracer (plutonium 236) was added to each sample before dissolution to determine chemical recovery in the separation procedure. Recoveries determined as less than 50% required sample re-analysis. Plutonium was isolated, purified, electrodeposited onto a metal planchet and analyzed by alpha spectrometry. Results were reported as disintegrations per minute 239-240 Pu and 238 Pu per gram of soil.

QUALITY CONTROL

The goal of the quality plan was to assure that data having the highest attainable precision and accuracy was obtained in the investigation. This goal required planned control of all project elements having impact on the integrity of the data.

It was the responsibility of the Rockwell sub-contractors to prepare and utilize complete quality assurance and quality control programs. These programs were reviewed and approved by the Rockwell project manager.

All activities at the sample sites were conducted in a manner to prevent damage to the land and to protect the integrity of the samples. Procedures were prepared and followed for maintaining chain of custody of samples from collection, through analysis and finally storage.

Sample identification was required to permit traceability of each sample and its related data from the map site through sample collection, analysis, and reporting. The quality plan included procedures for sample identification and certification. In order to further blind all samples, an independent escrow agent re-numbered all samples from a list of computer derived random numbers.

The integrity of all samples was maintained during sample collection, packaging, shipping, storage, preparation and laboratory processing. Samples were protected to avoid alteration of the chemical composition or other characteristics through contamination or alteration of the sample.

All equipment used for sample site location, sample collection and sample analysis was checked out and calibrated and maintained with records of all such activities kept in permanent log books. Certified standards were used for all calibrations.

The ^{236}Pu isotopic tracer used for recovery determinations was standardized against a National Bureau of Standards standard source. The tracer had a ^{238}Pu impurity less than 0.5% alpha activity and a ^{239}Pu impurity less than 0.1% alpha activity.

All standards used in the radiochemical procedures are traceable to National Bureau of Standards standards. Radiometric standards were used to determine alpha counter geometry factors.

Primary analyses were performed by the Eberline Instrument Corporation (EIC), Albuquerque, New Mexico. Quality control analyses were performed by LFE Environmental Analysis Laboratories (LFE), Richmond, California and Los Alamos Scientific Laboratory (LASL), New Mexico.

All three laboratories routinely participate in inter-laboratory cross-check programs conducted by EPA and DOE organizations. The results of these inter-laboratory collaborative programs are published by the sponsoring agency.

ANALYTICAL RESULTS

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The results of analyses for plutonium in the 71 soil samples collected in September, 1978 on lands adjacent to the Rocky Flats Plant are presented in Tables I and II and are shown at the actual sample sites on Figures 2 and 3. Summaries of the soil data are given in Tables III and IV. It should be noted that Figures 2 and 3 also include data obtained for the Rocky Flats land litigation. Concentrations of americium in these soil samples have been determined and are available upon special request.

Figure 2 gives the plutonium 239 and 240 concentrations in units of disintegrations per minute per gram of soil (size fraction less than 10 mesh). Figure 3 gives the same data converted to units of millicuries per square kilometer. This conversion was performed by multiplying d/m/g by gram weight of fines (<10 mesh) and dividing by the sample area (500 cm²). Changing units also required a ~~additional divisor of 111.~~ *multiplier of 4.5.*

Table I presents all the analytical data as reported, including all replicate analyses. The data are segregated into the various land parcels, i.e., sections 4, 6, 7, 19 and 24. In column 3 of Tables I and II, an assigned value is given for each sample site. This value was determined by taking the average of all the reported analyses for each sample. The plutonium concentrations in units of millicuries per square kilometer (m Ci/km²) are given in column 4 of Tables I and II.

Table II presents the same data as Table I, except they are listed by landowner.

Tables III and IV present listings of the data arranged by land sections. Included in the tables are number of sites per section, the two highest values, the two lowest values and the median for each section or portion of a section.

EVALUATION OF RESULTS

The analytical results for samples of soil from lands west and south of the Rocky Flats Plant indicate low concentrations of plutonium. In Section 4 the range is from 0.11 to 0.19 d/m/g (1-3 mCi/km²) with a median of 0.13 d/m/g (2 mCi/km²). The soil in Section 9 contains plutonium in the range between 0.05 and 0.22 d/m/g (1-2 mCi/km²) and the median is 0.12 d/m/g (2 mCi/km²). In Sections 21 and 22 the plutonium varies from 0.05 to 0.61 d/m/g (1-6 mCi/km²), with a median of 0.15 d/m/g (2 mCi/km²). Section 23 includes soils containing plutonium in the range from 0.03 to 0.28 d/m/g (1-6 mCi/km²) and the median is 0.10 d/m/g (2 mCi/km²). Section 24 viewed as whole shows plutonium levels between 0.02 and 0.39 d/m/g (0-6 mCi/km²) with a median of 0.04 d/m/g (1 mCi/km²). This section was also subdivided into two parcels, the northeast quarter section and the remainder of the section. The plutonium values for the quarter section fall in the range from 0.02 to 0.11 d/m/g (0-3 mCi/km²), with a median of 0.04 d/m/g (1 mCi/km²). The remainder of the section shows levels from 0.02 to 0.39 d/m/g (0-6 mCi/km²) and the median value is 0.07 d/m/g (2 mCi/km²). It should be recognized from Table IV that the values in millicuries per square kilometer were rounded to the nearest whole number. Values less than 0.5 are indicated as 0 mCi/km².

In summary, there are no plutonium concentrations in soil from Sections 4, 9, 21, 22, 23 and 24 greater than the Colorado Guideline of 2 d/m/g. Likewise, the analytical results show that there are no levels in these sections greater than the EPA Proposed Guideline of 200 mCi/km².

Samples of soil from Section 18 contain plutonium in the range between 0.14 and 2.0 d/m/g (2-38 mCi/km²) with a median of 0.7 d/m/g (10 mCi/km²). One sample with a concentration of 2.0 d/m/g is thus equal to the State Guideline but does not exceed it or the EPA Guideline.

Section 7 was sampled at 23 sites. The results show plutonium levels from 0.28 to 7.6 d/m/g (6-118 mCi/km²) with a median of 1.4 d/m/g (29 mCi/km²). Considering the south half of the section, the range of values is 0.39 to 2.5 d/m/g (9-60 mCi/km²) with the median value at 1.4 d/m/g (29 mCi/km²). There is therefore one sample in this half section with a plutonium concentration of 2.5 d/m/g (60 mCi/km²) which exceeds the Colorado Guideline but not that of the EPA. Since the median characterizes the parcel more completely than an individual sample, it is proposed that the half section should be evaluated on the basis of the median value of 1.4 d/m/g (29 mCi/km²).

The north half of Section 7 shows plutonium concentrations between 0.28 and 7.6 d/m/g (6-118 mCi/km²) with a median of 1.4 d/m/g (29 mCi/km²). Two samples produced results greater than the Colorado Guideline, but less than the EPA Proposed Guidance. The same argument for considering the median of 1.4 d/m/g (29 mCi/km²) should be applicable in this land parcel.

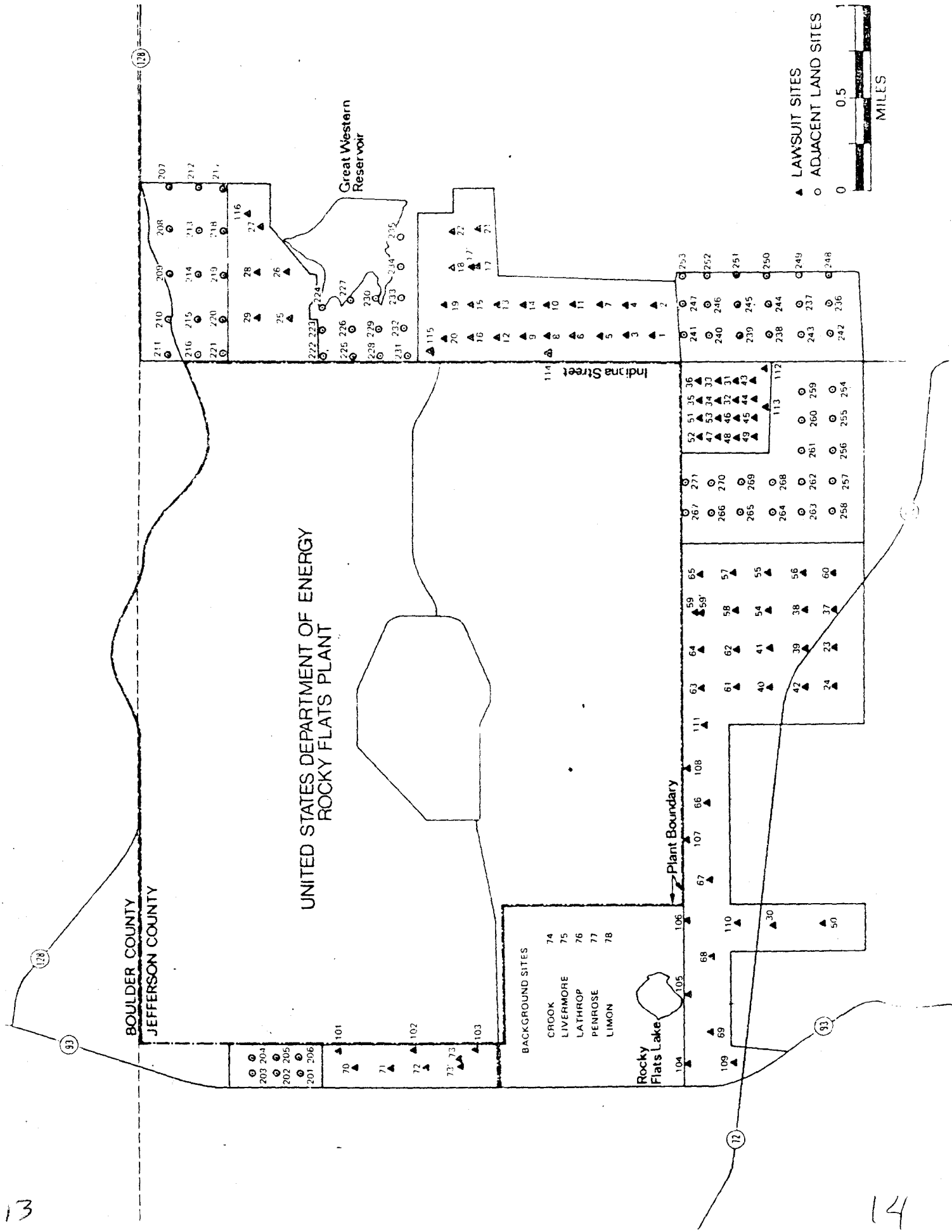
Soil samples were collected at 20 locations in Section 6. The results as summarized in Table IV, show plutonium concentrations in the range between 0.05 and 3.2 d/m/g (1-79 mCi/km²) with a median of 0.11 d/m/g (2 mCi/km²). The north half section had 15 samples and the plutonium concentrations fell in the range from

0.05 and 0.34 d/m/g (1-6 mCi/km²) with a median of 0.11 d/m/g (2 mCi/km²). These values are below both the Colorado Guideline and the EPA Guidance. The south half section produced plutonium concentrations in the range from 0.07 to 3.2 d/m/g (1-79 mCi/km²) and the median is 1.1 d/m/g (24 mCi/km²). One sample contained a level of plutonium greater than the Colorado Guideline but less than the EPA Guideline. The median value which characterizes the half section is only 1.4 d/m/g and is less than the guideline.

The data on plutonium concentrations in soil and air samples collected from lands involved in litigation have been evaluated by the Inhalation Toxicology Research Institute in Albuquerque, New Mexico. A report entitled "Defendant's Analysis Of Health Risks" has been submitted as an exhibit to U.S. District Court in Denver, Colorado. The conclusion of this report is as follows:

Potential radiation doses to people having unrestricted use of lands near the Rocky Flats boundary line have been estimated using different exposure models and different sets of environmental measurements. All of the approaches described above yielded similar results in estimating the radiation doses and in projecting the probabilities for human health injury. The most important risks to people from exposures to plutonium and americium are potential increases in their incidences of lung, bone and liver related cancers. The probabilities for deaths due to cancers ranged between 1 and 3 per hundred million persons per year. This level of risk was shown to be small in comparison to the risks from exposures to naturally-occurring radionuclides and other natural background radiations.

APPENDIX A



14



▲ LAWSUIT SITES
○ ADJACENT LAND SITES

0 0.5 MILES

15



▲ LAWSUIT SITES
○ ADJACENT LAND SITES

0 0.5 1
MILES

APPENDIX B

TABLE I

RESULTS OF TESTING FOR
PLUTONIUM CONCENTRATION
IN NEIGHBORING LANDOWNERS' SOIL

LISTED BY SECTION NUMBER

- * Designates LASL Results (in d/m/g \pm d/m/g error)
- ** Designates LFE Results (in d/m/g \pm % error)
- All Others are Eberline Results (in d/m/g \pm d/m/g error)

<u>Field Number</u>	<u>Pu-239 Analysis</u>	<u>Site Values d/m/g</u>	<u>mCi/km²</u>
<u>SECTION 4</u>			
201	0.08 \pm 0.02	0.11	1.18
	0.13 \pm 0.01		
202	0.13 \pm 0.02	0.13	2.28
203	0.17 \pm 0.02	0.17	2.55
	0.17 \pm 0.03		
204	0.14 \pm 0.02	0.16	2.24
	0.15 \pm 0.01		
	0.24 \pm 0.02		
	*0.162 \pm 0.02		
	**0.11 \pm 37		
205	0.10 \pm 0.01	0.11	2.01
	0.12 \pm 0.02		
	*0.102 \pm 0.01		
	**0.12 \pm 8		
206	0.19 \pm 0.01	0.19	2.54
<u>SECTION 6</u>			
207	0.20 \pm 0.02	0.25	4.58
	0.30 \pm 0.02		
208	0.11 \pm 0.01	0.11	2.21
209	0.16 \pm 0.01	0.16	2.76
210	0.10 \pm 0.01	0.10	2.08
	0.09 \pm 0.01		
	*0.091 \pm 0.01		
	**0.10 \pm 9		

211	0.12 ± 0.02	0.12	2.44
212	0.06 ± 0.02	0.11	1.97
	0.16 ± 0.02		
213	0.18 ± 0.02	0.18	3.54
214	0.23 ± 0.02	0.23	3.46
215	0.07 ± 0.01	0.07	1.55
216	0.05 ± 0.04	0.34	5.89
	0.12 ± 0.01		
	0.11 ± 0.02		
	$*1.33 \pm 0.07$		
	$**0.10 \pm 9$		
217	0.35 ± 0.07	0.28	4.45
	0.25 ± 0.02		
	0.25 ± 0.02		
	$*0.308 \pm 0.02$		
	$**0.220 \pm 6$		
218	0.06 ± 0.01	0.05	1.05
	0.04 ± 0.01		
219	0.02 ± 0.01	0.06	1.31
	0.10 ± 0.01		
220	0.08 ± 0.02	0.08	1.76
221	0.09 ± 0.01	0.09	1.71

SECTION 7

222	0.48 ± 0.04	0.48	9.54
223	0.61 ± 0.06	0.69	12.85
	0.76 ± 0.03		

224	0.64 \pm 0.07	0.60	11.48
	0.55 \pm 0.03		
225	1.54 \pm 0.14	1.67	33.06
	1.77 \pm 0.08		
	1.89 \pm 0.06		
	*1.71 \pm 0.07		
	**1.44 \pm 5		
226	0.80 \pm 0.04	0.80	17.45
227	0.28 \pm 0.02	0.28	5.96
228	1.72 \pm 0.08	1.72	29.22
229	1.16 \pm 0.06	1.16	25.80
230	1.34 \pm 0.08	1.53	32.92
	1.58 \pm 0.20		
	1.29 \pm 0.05		
	*1.53 \pm 0.04		
	**1.93 \pm 5		
231	10.7 \pm 0.5	7.56	118.12
	4.4 \pm 0.2		
232	1.67 \pm 0.06	1.67	34.51
233	1.86 \pm 0.10	2.46	44.28
	2.16 \pm 0.12		
	*3.13 \pm 0.11		
	**2.67 \pm 5		
234	1.66 \pm 0.09	1.66	32.59
235	1.31 \pm 0.10	1.31	25.13

SECTION 19

236	0.02 \pm 0.01	0.02	0.42
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237	0.10 ± 0.02	0.04	0.82
	0.03 ± 0.01		
	0.04 ± 0.01		
	$*0.016 \pm 0.004$		
	$**0.034 \pm 13$		
238	0.04 ± 0.02	0.04	0.77
	0.04 ± 0.01		
239	0.04 ± 0.01	0.04	0.92
240	0.01 ± 0.01	0.03	0.73
	0.05 ± 0.01		
241	0.07 ± 0.02	0.13	2.42
	0.18 ± 0.01		
242	0.05 ± 0.02	0.03	0.63
	0.01 ± 0.01		
	0.03 ± 0.01		
	0.02 ± 0.01		
	$*0.029 \pm 0.007$		
	$**0.029 \pm 18$		
243	0.08 ± 0.01	0.08	2.06
244	0.03 ± 0.01	0.03	0.75
245	0.40 ± 0.05	0.37	5.41
	0.33 ± 0.02		
246	0.08 ± 0.02	0.08	1.63
	0.07 ± 0.01		
247	0.14 ± 0.01	0.14	2.84

248	0.05 \pm 0.03	0.05	1.00
	0.03 \pm 0.01		
	0.06 \pm 0.01		
	*0.047 \pm 0.007		
	**0.056 \pm 13		
249	0.05 \pm 0.01	0.06	1.40
	0.06 \pm 0.01		
250	0.04 \pm 0.01	0.04	0.91
251	0.42 \pm 0.04	0.43	5.54
	0.44 \pm 0.03		
252	0.45 \pm 0.06	0.60	10.49
	0.74 \pm 0.07		
253	0.63 \pm 0.04	0.63	12.19

SECTION 24

254	0.06 \pm 0.02	0.09	2.03
	0.11 \pm 0.01		
255	0.03 \pm 0.01	0.03	0.74
	0.05 \pm 0.01		
	0.03 \pm 0.01		
	*0.033 \pm 0.007		
	**0.026 \pm 17		
256	0.02 \pm 0.01	0.02	0.59
257	0.04 \pm 0.01	0.04	0.90
258	0.03 \pm 0.01	0.02	0.46
	<0.01		
259	0.03 \pm 0.01	0.03	0.87

260	0.03 ± 0.01	0.03	0.59
261	0.03 ± 0.01	0.03	0.71
262	0.10 ± 0.02	0.11	2.74
	0.11 ± 0.01		
263	0.05 ± 0.01	0.05	1.18
264	0.07 ± 0.01	0.06	1.46
	0.04 ± 0.01		
265	0.06 ± 0.02	0.08	2.41
	0.08 ± 0.01		
	0.11 ± 0.01		
	$*0.078 \pm 0.007$		
	$**0.06 \pm 10$		
266	0.12 ± 0.02	0.12	2.71
267	0.16 ± 0.02	0.17	4.22
	0.17 ± 0.02		
268	0.10 ± 0.04	0.09	1.89
	0.12 ± 0.02		
	0.07 ± 0.01		
	0.10 ± 0.01		
	$*0.082 \pm 0.01$		
	$**0.09 \pm 10$		
269	0.09 ± 0.01	0.09	1.73
270	0.43 ± 0.06	0.39	6.12
	0.34 ± 0.03		
271	0.07 ± 0.02	0.08	1.96
	0.08 ± 0.01		

APPENDIX C

TABLE II

RESULTS OF TESTING FOR
PLUTONIUM CONCENTRATION
IN NEIGHBORING LANDOWNERS' SOIL

LISTED BY LANDOWNER

* Designates LASL Results (in d/m/g \pm d/m/g error)

** Designates LFE Results (in d/m/g \pm % error)

All Others Are Eberline Results (in d/m/g \pm d/m/g error)

<u>Field Number</u>	<u>Pu-239</u>	<u>Site Values</u>	
	<u>Analysis</u>	<u>d/m/g</u>	<u>mCi/km²</u>
JEFFCO AIR PARK ASSOCIATES, SECTION 6			
207	0.20 \pm 0.02	0.25	4.58
	0.30 \pm 0.02		
208	0.11 \pm 0.01	0.11	2.21
212	0.06 \pm 0.02	0.11	1.97
	0.16 \pm 0.02		
213	0.18 \pm 0.02	0.18	3.54
217	0.35 \pm 0.07	0.28	4.45
	0.25 \pm 0.02		
	0.25 \pm 0.02		
	*0.308 \pm 0.02		
	**0.220 \pm 6		
218	0.06 \pm 0.01	0.05	1.05
	0.04 \pm 0.01		
MARGARET I. SANDERS, EXECUTRIX, SECTION 6			
209	0.16 \pm 0.01	0.16	2.76
214	0.23 \pm 0.02	0.23	3.46
219	0.02 \pm 0.01	0.06	1.31
	0.10 \pm 0.01		
JOHN H. SHUTTLEWORTH, JR., SECTION 6			
210	0.10 \pm 0.01	0.10	2.08
	0.09 \pm 0.01		
	*0.091 \pm 0.01		
	**0.10 \pm 9		

211	0.12 ± 0.02	0.12	2.44
215	0.07 ± 0.01	0.07	1.55
216	0.05 ± 0.04	0.34	5.89
	0.12 ± 0.01		
	0.11 ± 0.02		
	$*1.33 \pm 0.07$		
	$**0.10 \pm 9$		

STEPHEN P. & CHERYL A. KAATZ, SECTION 6

220	0.08 ± 0.02	0.08	1.76
221	0.09 ± 0.01	0.09	1.71

CITY OF BROOMFIELD, SECTION 7

222	0.48 ± 0.04	0.48	9.54
223	0.61 ± 0.06	0.69	12.85
	0.76 ± 0.03		
224	0.64 ± 0.07	0.60	11.48
	0.55 ± 0.03		
225	1.54 ± 0.14	1.67	33.06
	1.77 ± 0.08		
	1.89 ± 0.06		
	$*1.71 \pm 0.07$		
	$**1.44 \pm 5$		
226	0.80 ± 0.04	0.80	17.45
227	0.28 ± 0.02	0.28	5.96
228	1.72 ± 0.08	1.72	29.22
229	1.16 ± 0.06	1.16	25.80

230	1.34 ± 0.08	1.53	32.92
	1.58 ± 0.20		
	1.29 ± 0.05		
	$*1.53 \pm 0.04$		
	$**1.93 \pm 5$		
231	10.7 ± 0.5	7.56	118.12
	4.4 ± 0.2		
232	1.67 ± 0.06	1.67	34.51
233	1.86 ± 0.10	2.46	44.28
	2.16 ± 0.12		
	$*3.13 \pm 0.11$		
	$**2.67 \pm 5$		
234	1.66 ± 0.09	1.66	32.59
235	1.31 ± 0.10	1.31	25.13

AUBREY E. & CORA E. LADWIG, SECTION 19

239	0.04 ± 0.01	0.04	0.92
240	0.01 ± 0.01	0.03	0.73
	0.05 ± 0.01		
241	0.07 ± 0.02	0.13	2.42
	0.18 ± 0.01		
245	0.40 ± 0.05	0.37	5.41
	0.33 ± 0.02		
246	0.08 ± 0.02	0.08	1.63
	0.07 ± 0.01		
247	0.14 ± 0.01	0.14	2.84
	0.42 ± 0.04	0.43	5.54
	0.44 ± 0.03		

252	0.45 ± 0.06	0.60	10.49
	0.74 ± 0.07		
253	0.63 ± 0.04	0.63	12.19

TWIN LAKES JOINT VENTURE, SECTION 19

238	0.04 ± 0.02	0.04	0.77
	0.04 ± 0.01		
243	0.08 ± 0.01	0.08	2.06
242	0.05 ± 0.02	0.03	0.63
	0.01 ± 0.01		
	0.03 ± 0.01		
	0.02 ± 0.01		
	$*0.029 \pm 0.007$		
	$**0.029 \pm 18$		
236	0.02 ± 0.01	0.02	0.42
237	0.10 ± 0.02	0.04	0.82
	0.03 ± 0.01		
	0.04 ± 0.01		
	$*0.016 \pm 0.004$		
	$**0.034 \pm 13$		
244	0.03 ± 0.01	0.03	0.75

ALKIRE INVESTMENT COMPANY, SECTION 19

248	0.05 ± 0.03	0.05	1.00
	0.03 ± 0.01		
	0.06 ± 0.01		
	$*0.047 \pm 0.007$		
	$**0.056 \pm 13$		

249	0.05 ± 0.01	0.06	1.40
	0.06 ± 0.01		
250	0.04 ± 0.01	0.04	0.91

WILLIAM J. FORTUNE & JOHN A. FORTUNE, TRUSTEE, SECTION 24

254	0.06 ± 0.02	0.09	2.03
	0.11 ± 0.01		
255	0.03 ± 0.01	0.03	0.74
	0.05 ± 0.01		
	0.02 ± 0.01		
	$*0.033 \pm 0.007$		
	$**0.026 \pm 17$		
256	0.02 ± 0.01	0.02	0.59
257	0.04 ± 0.01	0.04	0.90
258	0.03 ± 0.01	0.02	0.46
	<0.01		
263	0.05 ± 0.01	0.05	1.18
264	0.07 ± 0.01	0.06	1.46
	0.04 ± 0.01		

GLENN YOUNG & COMPANY, SECTION 24

259	0.03 ± 0.01	0.03	0.87
260	0.03 ± 0.01	0.03	0.59
261	0.03 ± 0.01	0.03	0.71
262	0.10 ± 0.02	0.11	2.74
	0.11 ± 0.01		

265	0.06 \pm 0.02	0.08	2.41
	0.08 \pm 0.01		
	0.11 \pm 0.01		
	*0.078 \pm 0.007		
	**0.06 \pm 10		
266	0.12 \pm 0.02	0.12	2.71
267	0.16 \pm 0.02	0.17	4.22
	0.17 \pm 0.02		
268	0.10 \pm 0.04	0.09	1.89
	0.12 \pm 0.02		
	0.07 \pm 0.01		
	0.10 \pm 0.01		
	*0.082 \pm 0.01		
	**0.09 \pm 10		
269	0.09 \pm 0.01	0.09	1.73
270	0.43 \pm 0.06	0.39	6.12
	0.34 \pm 0.03		
271	0.07 \pm 0.02	0.08	1.96
	0.08 \pm 0.01		

EDWARD J. & MARGARET MARY HOGAN, SECTION 4

201	0.08 \pm 0.02	0.11	1.18
	0.13 \pm 0.01		
202	0.13 \pm 0.02	0.13	2.28
203	0.17 \pm 0.02	0.17	2.55
	0.17 \pm 0.03		
204	0.14 \pm 0.02	0.16	2.24

204 (Cont'd)

$$0.15 \pm 0.01$$

$$0.24 \pm 0.02$$

$$*0.162 \pm 0.02$$

$$**0.11 \pm 37$$

205

$$0.10 \pm 0.01$$

0.11

2.01

$$0.12 \pm 0.02$$

$$*0.102 \pm 0.01$$

$$**0.12 \pm 8$$

206

$$0.19 \pm 0.01$$

0.19

2.54

APPENDIX D

TABLE III

Plutonium Summaries

(d/m/g)

<u>Location</u>	<u>No. of Sites</u>	<u>High Values</u>	<u>Low Values</u>	<u>Median</u>
Section 6	20	3.2, 1.8	0.05, 0.06	0.11
North half	15	0.34, 0.28	0.05, 0.06	0.11
South half	5	3.2, 1.8	0.07, 0.09	1.1
Section 7	23	7.6, 2.5	0.28, 0.39	1.4
North half	14	7.6, 2.5	0.28, 0.48	1.4
South half	9	2.5, 1.9	0.39, 0.87	1.4
Section 18	14	2.0, 1.3	0.14, 0.18	0.7
Section 19	18	0.63, 0.60	0.02, 0.03	0.07
Section 24	36	0.39, 0.17	0.02, 0.02	0.04
Northeast				
Quarter	18	0.11, 0.09	0.02, 0.02	0.04
Remainder	18	0.39, 0.17	0.02, 0.02	0.07
Section 23	21	0.28, 0.18	0.03, 0.03	0.10
Section 21 and 22	14	0.61, 0.24	0.05, 0.07	0.15
Section 9	8	0.22, 0.18	0.05, 0.07	0.12
Section 4	6	0.11, 0.17	0.11, 0.11	0.18
Background	5	0.07, 0.06	0.02, 0.05	0.06

TABLE IV

Plutonium Summaries
(mCi/km²)

<u>Location</u>	<u>No. of Sites</u>	<u>High Values</u>	<u>Low Values</u>	<u>Median</u>
Section 6	20	79, 38	1, 1	2
North half	15	6, 5	1, 1	2
South half	5	79, 38	1, 2	24
Section 7	23	118, 60	6, 9	29
North half	14	118, 44	6, 10	28
South half	9	60, 40	9, 12	29
Section 18	14	38, 27	2, 3	10
Section 19	18	12, 10	0, 1	2
Section 24	36	6, 4	0, 0	1
Northeast				
Quarter	18	3, 2	0, 0	1
Remainder	18	6, 4	0, 1	1
Section 23	21	6, 3	1, 1	2
Section 21 and 22	14	6, 4	1, 1	2
Section 9	8	2, 2	1, 1	2
Section 4	6	3, 3	1, 2	2
Background	5	2, 2	0, 1	2

TABLE V
QUALITY CONTROL RESULTS PLUTONIUM 239 in d/m/g

	1	2	Eberline 3	4	5	LASL	LFE
Blanks	0.05	0.03	0.06	0.03	0.02	0.024	0.022
	0.05	0.05	0.03	0.06	0.03	0.018	0.037
	0.05	0.04	0.02	0.01			
	0.03	0.03	0.01				
Synthetic Standard	4.23 3.72		4.29 4.27	4.34 3.71	3.88 4.20	7.44	3.70
Synthetic Standard	12.1 12.0	9.09 11.0 12.15 12.0	11.5	12.3 12.14		10.9	10.5
Consensus Standard	2.64 1.56			1.12 2.46	1.17 1.34	0.135	
Consensus Standard	8.35 5.36	4.94 3.92	5.24 9.59	6.21 6.13			23.4
Consensus Standard		0.59 0.54	0.89 0.45		0.39 0.50	0.497	0.48